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**THE WAYS TO SOLVE IN THE USSR THE PROBLEM OF SANITARY
PROTECTION OF THE ENVIRONMENT FROM RADIOACTIVE
CONTAMINATION**

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The problem of sanitary protection of the atmosphere (ambient air), reservoirs, underground waters and soil from contamination with radioactive wastes is considered in the Soviet Union as subordinate to the main problem, i.e., to the problem of ensuring radiation safety to the population.

Economic, technical and other aspects have here but second-rate importance.

The problem is governed by the respective sanitary rules and regulations published by the State sanitary inspection bodies of the Ministry of Health and lies within the jurisdiction of these bodies.

These rules and regulations are valid throughout the entire territory of the Soviet Union and mandatory for all the Ministries and State Departments of the USSR.

While elaborating the sanitary legislation, the utmost importance is adhered to the preventive sanitary surveillance which is the care of the State sanitary inspection bodies.

In particular, the chief sanitary questions which proceed from the problem under consideration are solved in the course of planning, and they incorporate the following: selection of the construction site for the respective object with a due allowance for topographic, climatic, geological, hydrogeological, sanitary and other conditions which make it possible to arrange sanitary protection or forbidden zones (belts); selection of water-supply source; creation of optimum conditions for rendering radioactive wastes harmless and for safe disposal of wastes.

Maximum allowable concentrations of radioactive substances in the ambient air and in the water of the open reservoirs serve as the main criterion for sanitary examination of projects (prior to getting the approval of the State bodies of sanitary surveillance (inspection).

Proceeding from the fact, that protection of the water-supply sources from contamination is of great importance, the Soviet bodies of sanitary legislation have established the maximum allowable concentrations of radioactive substances for the water of open reservoirs, thereby rendering the initial data for projecting the sewerage system reliable, and making the sanitary supervision over radiative purity of the reservoirs easier.

Moreover, when liquid radioactive wastes are disposed of, one does not take into consideration the fact that radioactive substances can be diluted with water in the reservoir, i.e., the actual concentration of the radioactive substances in liquid waste at the place of its disposal

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into the reservoir must not exceed the maximum allowable concentrations established for the water of the particular reservoir. The mentioned requirement makes provision for limitation of radioactive substances migration from the reservoir and, consequently, for their penetration into the human organism by means of alimentary chains taking into account the ability of the economically-useful hydrobionts to absorb radioactive substances from water and accumulate them in the tissue.

In the sanitary legislation, provision is made for especially strict requirements to the underground water-supply sources whose water should be free of artificial radioactive substances.

The utmost strict sanitary requirements to the underground water-supply sources are necessitated by the peculiarities of radioactive substances migration in the underground waters and by the fact that disactivation of the aquifer, if polluted, is a very complicated thing.

In case of necessity, "sanitary protection" or forbidden zones are arranged in the Soviet Union.

The territory dimensions of zones and the sanitary conditions within them are regulated by the sanitary legislation. Provisions for the values of the maximum permissible concentrations of radioactive substances in the atmosphere (for the population) are made for the areas beyond the boundaries of the sanitary protection or forbidden zones; less rigid regulations are established for the areas within the forbidden zones, since they are not inhabited.

Such an approach to the problem in sanitary normalizing offers initial parameters required for calculations in the course of planning or projecting, besides, it allows to perform routine checks of the ambient air for the radiative purity and to ensure radiative safety for the population.

The essence of solving the problem of sanitary protection of the environment is to protect from contamination with radioactive substances the natural formations which may offer direct contact to the population or facilitate the radioactive substances migration into the human organism. This is obtained by varying the approaches to utilizing various methods depending upon the nature, amount, composition of radioactive wastes and upon local conditions.

It is obvious that the practical solution of the problem is a very difficult task, if we take into consideration the variety of radioactive isotopes, that of their concentration and different chemical compositions of the wastes containing radioactive isotopes.

Sanitary considerations are the principal criterion determining the completeness and regidity of the requirements presented by the problem.

The main and decisive requirement is to minimize the amount of liquid and gaseous wastes to be disposed of into the environment. This is obtained mainly by way of rationalizing the technological processes and by reutilizing the liquid radioactive wastes in the closed reversible systems.

The second role is assigned to localization of liquid and solid wastes at the places of their origination, with subsequent burial of the wastes in special capacities, arranged, as a rule, under the surface of the ground.

The disposal of radioactive wastes into the sea is not resorted to in the Soviet Union, due to the sanitary considerations and in conjunction with potential hazard of radioactive contamination of the hydrosphere.

The third in importance is disactivation of radioactive wastes which are subjected to disposal.

In the Soviet Union, two trends, are actually adhered to, namely:

concentration of radioactive substances from the large volumes of the slightly radioactive liquid and gaseous wastes, with subsequent burial of concentrates; and hold-up of liquid, gaseous and solid wastes containing the short living radioisotopes.

Dispersal and dilution of radioactive wastes are considered to be auxiliary methods and resorted to in all cases when other methods have been exhausted, and also in case of disposal of wastes which contain radioactive substances with concentrations amounting to the maximum permissible concentrations.

In all cases, these methods are resorted to, provision should be made as to the reliable safety for the population. The problem of sanitary protection of the atmosphere is a principal one of many problems pertaining to the environment protection from radioactive contamination. It is considered principal due to the opportunity of direct Air Pollution Health Effect and owing to the possible migration of the radioactive substances from the polluted air into the human organism by means of biological chains.

The most effective prevention of radioactive Air Pollution can be obtained by means of such technological processes which ensure maximum utilization of raw materials and restrict the formation of radioactive discharges into the atmosphere.

Thus, for instance, it is known that amidst the places where gaseous and aerosol discharges are formed at the water-moderated water-cooled reactors, the water deaeration of the first circuit is the most important one. If the reactor is equipped with the deaeration closed circuit, and the detonating gas is additionally afterburnt, the value of radioactive discharges through the ventilation system is more than 10 times reduced.

Respectively, the ambient air contamination with radioactive substances will be also reduced.

Consequently, the introduction of respective changes into the technological processes makes it possible to diminish essentially the amount of radioactive substances disposed into the atmosphere.

It is of essential importance to introduce, with a view of protecting the ambient air from radioactive contamination, gas purifiers, dust collectors and recuperation installations (plants) which must be employed depending on the aggregate state of radioactive substances (gas, aerosol), physicochemical state of radioisotopes, etc. Alongside with the use of different absorbers and special filters, provision is made for utilizing other devices presenting good effect.

If the radioactive substances incorporated into the composition of the discharges cannot be caught by the purifying devices, and, in addition, they possess a short period of half-decay, then the hold-up or cooling method is resorted to.

The reference is made to the discharges of the reactors which contain argon-41. For which purpose, the use is made of the gas holders in which the radioactive gas subjected to disposal is kept during the time equivalent to not less than 10 periods of half-decay.

The experience in operating such plants has shown that the employment of gas holders reduces the escape of argon-41 into the atmosphere.

In combination with the above-mentioned active methods of sanitary protection of the atmosphere, the use is made of other methods, such as dilution and dissipation.

Radioactive gases are diluted in gas outlet tubes by means of forcing the pure air into the tube.

Dissipation is gained by erecting high stacks for discharge of radioactive gases.

The above-mentioned methods are employed only at the final stage of decontamination of gas discharges, with a view of adding to the scope of safety.

In addition to technical means of ensuring radiation safety in regions adjacent to atomic power stations and other installations the Soviet legislation stipulates that respective layout and sanitary protection zones should be provided.

The experience, gained in the Soviet Union, has made it possible to work out specified sanitary requirements to the arrangement of various types of installations, and so on, since they are potential sources of Air Pollution with radioactive substances, and, therefore, sanitary protection or forbidden zones are assigned for them in a legislative manner.

The establishment of such zones is considered a supplementary measure to preclude the population from contacting with radioactive substances. For this purpose, it is prohibited for the population to settle down within the boundaries of the sanitary protection (or forbidden) zones. Besides, provisions are made for some restrictions pertaining to the use of the territory.

The dimensions (boundaries) of the sanitary protection (or forbidden) zones depend upon the nature and capacity of the potential source of contamination, the local conditions being taken into consideration.

The project (plan) of the sanitary protection zone is elaborated simultaneously with the project of the particular installation, and approved in accordance with established procedure.

The preservation of radioactive purity of the open reservoirs is an important problem of sanitary protection of environment from contamination with radioactive substances.

It is known that the liquid radioactive wastes greatly endanger the reservoirs. Indirect contamination of the reservoirs with solid and gaseous wastes cannot be completely excluded, though possible, it may be neglected in practice.

Amidst the liquid radioactive wastes, the slightly active liquid* waste presents the utmost danger for the open reservoirs from the point of view of their contamination.

While highly active and mean active liquid wastes appear at the restricted number of places and the amount of waste is relatively small, the slightly active liquid-waste drains are formed in a great number of institutions which carry out the research work at open radioactive substances.

The amount of the radioactive wastes may widely vary, ranging from tens of liters up to hundreds and even thousands of cubic meters per day.

* Liquid waste is considered slightly active if the concentration of beta-particle radiators is equal to 10^{-6} curie/l.; mean active up to 1 curie/l. and highly active-exceeding 1 curie/l.

As the disposal of mean and highly active liquid wastes into the open reservoirs is not generally allowed in the Soviet Union, otherwise it might result in contaminating the rivers, lakes, therefore the effect of these wastes can be only indirect (in case of an accidental leak of capacities) but since provision is made for precaution measures, the mentioned effect is actually negligible.

Therefore, in planning the sanitary protection of open reservoirs, the main attention is paid to the problems connected with prevention of the slightly active liquid-waste effect upon the reservoirs.

The prevention measures include, first and foremost, measures aimed at diminishing the amount of formed liquid wastes, which is obtained mainly by means of improving the technological processes under which the liquid radioactive wastes are formed.

The second way of preventing open reservoirs contamination is to organize closed system of water-supply with the re-use of waste waters either disactivated or not prior to being re-used. This is the way of excluding the radioactive drain waters emission into the open reservoirs.

Only small amounts of the liquid-waste drain, which cannot be re-used, are allowed, as an exception, to be disposed of into the open reservoirs, after being disactivated.

One of the examples to be referred to is the drain waters from shower-baths. The return of these waters for the re-use involves the reduction of their quality to the condition of the drinking water, which, though possible in practice, is not advisable from aesthetical and economical points of view.

Localization of drain waters by means of utilizing them in the recirculation systems of water-supply has been verified by experience.

The systems provided with first and second closed circuits which are in operation at the atomic power plants are considered most perfect as for sanitary conditions. With a view of maintaining the water composition of the reactor first circuit, provision is made for its continuous purification reducing the concentration of the radioactive substances by 2 to 3 orders.

The waters from overload ponds of the atomic power plants as well as washing and drain waters from laundries are also subjected to purification and re-use.

Thus, the localization of liquid radioactive wastes in closed recirculation systems of water-supply is one of the promising methods playing the significant part in sanitary protection of reservoirs. But the above-mentioned methods are employed mainly in those cases when considerable amounts of drain waters are available. Therefore, the Soviet sanitary legislation allows, in some cases, drain waters to be disposed of into reservoirs after they are decontaminated and provided the content of the radioactive substances in drain waters at the place of their discharge into the reservoir will not exceed the value of the maximum permissible concentrations established for the water of the reservoir. This can be accomplished, depending on the actual conditions, in two ways: by means of disactivation and dilution of drain waters before the discharge into the reservoir.

In those cases when the slightly active drain waters enter the town sewerage system, the content of radioactive substances in them (with due allowance for the isotope composition) is allowed to be 10 or 100 times in excess of the maximum permissible concentrations, with a view

of diluting them with inactive drain waters of the sewerage system to the required level of concentration.

The experience shows, that the mentioned requirements, as applied to the conditions of big towns and cities, completely exclude the possibility of contaminating reservoirs.

The problem of sanitary protection of reservoirs from contamination with radioactive substances, which are contained in slightly active wastes, is being successfully solved in the Soviet Union in the above-mentioned ways. But there is one more problem directly connected with the problem of wastes decontamination, and not less important from the sanitary point of view. That is the problem of preserving the underground waters in purity. The migration of radioactive substances in the aquifers of the rocks is more restricted as compared with that in the atmosphere and in the open reservoirs.

To ensure the proper sanitary conditions of life for the population of the Soviet Union, certain measures have been and being taken to minimize, on the territory of the Soviet Union, as far as possible, the number of places (areas) contaminated with radioactive substances. Therefore, solid wastes and small amount of liquid mean active wastes formed at the research, medical and other institutions and establishments are sent by the latter to the specially-assigned burial centres which attend the objects of the entire Region, District or a Town. Plants and establishments which get considerable amount of wastes are allowed to arrange burial grounds of their own.

The area assigned for the burial centres must be rarely inhabited, with natural conditions prohibiting the radioactive substances migration into the environment including the underground waters. Sanitary protection (or forbidden) zones are established around these burial centres.

While solving the problem of protecting the underground waters from pollution with radioactive substances, much attention is paid to the reduction of liquid wastes volumes subject to burial. The work to make these wastes solid is carried out, with a view of subsequent burial of the wastes into the ground.

For instance, slightly and mean active liquid wastes are used for manufacturing the concrete during case-hardening of solid wastes.

In solving the problem of sanitary protection of the environment from contamination with radioactive wastes, an essential role is assigned to the arrangement of control.

Taking into account the great significance of this measure, the Soviet Union has established an effective system of control.

Control performed by the Radiation Monitoring Service of the respective Institutions consists in constant observation over the activity of gaseous, liquid and solid radioactive wastes disposed into the environment as well as over the radiative situation predominant in the vicinity within the sphere of waste possible spread.

If it is detected that the contamination has exceeded maximum allowable concentrations the particular organization takes necessary measures to localize it.

The Public Health Services are systematically notified about the results of observation and the measures taken.

Control is also performed by the sanitary services (bodies) of the Ministry of Health.

Their task is to specify requirements based on the All-Union sanitary legislation and regulating the conditions for the use and disposal of radioactive wastes; to irregularly check the purifying devices for proper operation and the waste disposed into the atmosphere and reservoirs for the content of radioactive substances, as well as the respective objects of the environment for the content of radioactive substances.

Irrespective of the successes gained by the Soviet Union in the field under consideration, the research-work is continuously carried out, with a view of gaining the maximum effect in decontaminating the probable sources of the environment radioactive wastes pollution and of ensuring the complete radioactive safety for the population.

The work includes: further improvement of technological processes with a view of restricting the amount of liquid and gaseous wastes; mastering of methods used for solidifying liquid radioactive wastes proper and in combination with solid wastes; further perfection of normalization problems including the verification of values of the radioactive substances maximum permissible concentrations, of the human maximum tolerance dose values, the sanitary conditions for the disposal of radioactive wastes; differentiation of the requirements to be met by the sanitary protection (or forbidden) zones depending upon the nature of contaminating agents, etc.

The obtained experience pertaining to the prevention of the ambient medium contamination, as well as the successful development of research-work in that field make it possible to believe that the problem of sanitary protection of the environment from contamination with radioactive wastes will find the complete solution in the near future.